

## Session 19

---

**Course Title:** Floodplain Management

**Module:** Risk

**Session 19:** Mitigating Flood Losses

**Authors:** Larry A. Larson, PE, CFM  
Rod E. Emmer, Ph.D., CFM

**Time:** 75 minutes

---

### Objectives (PP19.1)

At the end of this session, students should be able to:

- 19.1 Explain the beneficial and detrimental attributes of structural mitigation practices
  - 19.2 Explain the beneficial and detrimental attributes of nonstructural mitigation practices
  - 19.3 Apply mitigation practices to a flood problem
- 

### Scope

Students should already be able to explain floods as hazards and how communities and individuals are at risk. Session 19 builds on the concept of floodplain management as presented in Session 18.

The overall goal of Session 19 is to explain the importance of mitigation in preventing flood damages, protecting existing and future development, reducing injuries, and avoiding loss of life

In this session, the instructor introduces and discusses the range of structural and nonstructural mitigation practices. Application of these actions to mitigate flood impacts demonstrates the effectiveness and limitations of each option. In consideration of the effectiveness and limitations each option, students will be prepared to apply the range of structural and nonstructural mitigation practices to mitigate flood impacts in a riverine landscape.

Exercises give the students an opportunity to apply what they learned so as professional floodplain managers they will be able to make decisions that are more informed. These exercises are opportunities for engaging the class and are implemented at the instructor's discretion.

## **Readings**

### *Required Student Readings*

Godschalk, D.R., T. Beatley, P. Berke, D.J. Brower, E.J. Kaiser, C.C. Bohl, R.M. Goebel. 1999. "Chapter 2. Evolving Mitigation Policy Directions." *Natural Hazard Mitigation. Recasting Disaster Policy and Planning*. Washington, D.C.: Island Press. pp. 27-87.

Tennessee Valley Authority. 1983. *FLOODPLAIN MANAGEMENT: THE TVA EXPERIENCE*. TVA/ONRED/AWR 86/55. Division of Economic and Community Development. Knoxville, TN. December. 80 p.

United States Water Resources Council. 1981. *FLOODPLAIN MANAGEMENT HANDBOOK*. Prepared by Flood Loss Reduction Associates. Washington, D.C.: US Government Printing Office. September. 69 p. plus appendix.

### *Instructor Readings*

Association of State Floodplain Managers. 2003. *No Adverse Impact. A Toolkit for Common Sense Floodplain Management*. April 23 Draft. Madison, WI. 79 p.

Eadie, C., R.E. Emmer, A.M. Esnard, S. Michaels, J. Monday, C. Philipsborn, B. Phillips, d. Salvesen. 2001. *Holistic Disaster Recovery. Ideas for Building Local Sustainability after a Natural Disaster*. Natural Hazards Research and Applications Information Center, University of Colorado, Boulder, CO. [www.colorado.edu/hazards/](http://www.colorado.edu/hazards/)

Federal Emergency Management Agency. 1997. *Report on Costs and Benefits of Natural Hazard Mitigation*. FEMA-294/7/97.

Federal Emergency Management Agency. 2003. *Developing the Mitigation Plan. Identifying Mitigation Actions and Implementation Strategies. State and Local Mitigation Planning How-to Guide*. FEMA 386-3. April.

Godschalk, D.R., T. Beatley, P. Berke, D.J. Brower, E.J. Kaiser, C.C. Bohl, R.M. Goebel. 1999. "Chapter 1. Mitigating Natural Hazards: A National Challenge." *Natural Hazard Mitigation. Recasting Disaster Policy and Planning*. Washington, D.C.: Island Press. pp. 3-25.

Mileti, D.S. 1999. "5. Influences on the Adoption and Implementation of Mitigation." *Disasters by Design. A Reassessment of Natural Hazards in the United States*. Washington, D.C.: Joseph Henry Press. pp. 135 - 154.

Mileti, D.S. 1999. "6. Tools for Sustainable Hazards Mitigation." *Disasters by Design. A Reassessment of Natural Hazards in the United States*. Washington, D.C.: Joseph Henry Press. pp.155 - 207.

### *Background References*

The Federal Interagency Floodplain Management Task Force. 1994. *A Unified National Program for Floodplain Management 1994*. FEMA 248/June.

The Federal Interagency Floodplain Management Task Force. 1996. *Protecting Floodplain Resources. A Guidebook for Communities*. FEMA 268/June. 2nd Edition

Federal Emergency Management Agency. 2002. *Getting Started. Building Support for Mitigation Planning. State and Local Mitigation Planning How-to Guide*. FEMA 386-1. September.

Federal Emergency Management Agency and the National Park Service. 1994. *A Multi-Objective Flood Mitigation Plan. Vermillion River Basin, South Dakota*. FEMA, Region VIII and the Rivers, Trails and Conservation Assistance Program of the National Park Service, Rocky Mountain Region. Denver, CO.

Federal Emergency Management Agency and the National Park Service. 1994. *A Multi-Objective Planning Process for Mitigating Natural Hazards*. FEMA, Region VIII and the Rivers, Trails and Conservation Assistance Program of the National Park Service, Rocky Mountain Region. Denver, CO.

Godschalk, D.R., T. Beatley, P. Berke, D.J. Brower, E.J. Kaiser, C.C. Bohl, R.M. Goebel. 1999. "Chapter 13. Mitigating Natural Hazards: Planning for Sustainable Communities." IN: *Natural Hazard Mitigation. Recasting Disaster Policy and Planning*. Washington, D.C.: Island Press. pp. 525-552.

National Science Foundation. 1980. *A Report on Flood Hazard Mitigation*. Washington, D.C. September. 253 p.

Paterson, R.G. 1998. "The Third Sector: Evolving Partnerships in Hazard Mitigation." IN: R.J. Burby (ed.) *Cooperating with Nature. Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*. Washington, D.C.: Joseph Henry Press. pp. 203 - 230.

The Task Force On The Natural And Beneficial Function Of The Floodplain. 2002. *The Natural And Beneficial Functions Of Floodplains Reducing Flood Losses By Protecting And Restoring The Floodplain Environment*. A Report For Congress. FEMA 409, June.

United States Army Corps of Engineers. 1983. *Seminar Proceedings. Implementation of Nonstructural Measures*. Civil Works Directorate, Ft. Belvoir, VA, November 15-17, 1982. Policy Study 83-G520.

## **General Requirements**

Instructor should prepare copies and distribute a handout of the new terms (19H1) that will be added to the student's course Glossary begun in Session 1.

When distributing the handouts the Instructor should remind students that we must agree on the meaning of terms, so we can more effectively communicate with other professionals, local decision-makers, and the general public. By avoiding any misunderstandings when speaking about mitigation, they will have done a service to their community by saving them time and money. The students should develop a personal Glossary that they continually update as they work through classes and, more important, when they move into their professional career. Remind students that they are serving as the interpreter (translator) of technical concepts for local officials and decision-makers with little if any training, experience, or background in floodplain management.

The instructor may elect to review selected terms discussed in Sessions 15 - 18. By refreshing the students' memory at the beginning of Session 19, the instructor draws their attention to again thinking about floods and floodplain management.

## **Remarks (PP19.2 – Mitigation Measures)**

Session 18 discussed the history, elements, and methodologies that makeup floodplain management. One of the most important elements of floodplain management is mitigation, the actions taken to eliminate or reduce to an acceptable level the undesired consequences of floods. For the community and individual this means preventing flood damages, protecting existing landuses and future development, reducing injuries, and avoiding loss of life. Mitigation measures include a range of structural and nonstructural practices that when implemented have positive (favorable) characteristics and negative (adverse) characteristics that should be considered by decision-makers when addressing flood damage reduction. Session 19 presents the forms of structural and nonstructural practices (approaches), summarizes their functions, and identifies the beneficial and detrimental attributes of each. Ultimately, the overall intent of flood damage reduction through mitigation measures is No Adverse Impact (**PP19.3 – No Adverse Impact**) on the property and rights of others while solving flood problems.

**Objective 19.1**      **Explain the beneficial and detrimental attributes of structural mitigation practices (PP19.4 – Structural Mitigation Practices)**

**I.                      What is Structural Mitigation?**

- A. Structural mitigation includes corrective measure (practices) or approaches that modifying the floods themselves through the construction of selected engineering works.
  - 1. Think of structural measures as keeping floodwaters away from developments, populated areas, and agricultural lands by decreasing runoff, increasing channel capacity, or containing, diverting, or storing excess waters.
- B. We modify floods in several ways (U.S. Water Resources Council, 1981, p. 30):
  - 1. Dams and reservoirs
  - 2. Levees and walls
  - 3. Channel alterations
  - 4. Diversions
  - 5. Land treatment
  - 6. Onsite detention
- C. Each of these measures is intended to protect an area rather than a particular property (parcel) or person. As such, these public works projects require little disruption to homes, businesses, and life styles for most floodplain occupants.

**Interactive Class Activity:**

Ask students to name specific examples in their area that are instances of structural mitigation.

- D. According to the U.S. Water Resources Council (1981, p. 30) several problems are associated with large public works construction projects: **(PP19.5 - Dissadvantages)**
  - 1. *Lengthy and complex planning and design.*
  - 2. *Require heavy construction and high costs.*
  - 3. *Potential for making flood damages outside the project more severe.*
  - 4. *Potential for catastrophic losses if design levels are exceeded.*
  - 5. *Potential for creating a false sense of security about the extent of protection provided.*

6. *Need for careful and costly routine inspection, operation, and maintenance.*
7. *Possible detrimental effects to the natural environment.*
- E. The Association of State Floodplain Managers (2003, pp. 45-46) offers a similar list of potential adverse impacts when floods are modified. Construction projects:
  1. *Disturb the land and disrupt natural water flows, often destroying habitats.*
  2. *Are built to a certain flood protection level that can be exceeded by a larger flood, causing even more damage than might have occurred without the structure.*
  3. *Can create a false sense of security when people protected by a structure believe that no flood could ever reach them.*
  4. *Require regular maintenance to ensure that they continue to provide protection, something that is often neglected over the years. On structural projects, operation and maintenance are usually a local cost.*
  5. *Are expensive, sometimes requiring capital bond issues and/or cost sharing with local, regional, or state agencies.*
  6. *Such as levees and floodwalls can divert flood flow onto other properties and reduce the floodplain's storage capacity.*
  7. *Can alter the timing of flood peaks, causing increased flooding on other properties.*

## II. Beneficial and detrimental attributes of structural mitigation practices

### A. Dams and reservoirs (**PP19.6 – Dams and Reservoirs**)

1. Functions
  - a. Dams and reservoirs such as Grand Coulee in Washington state (**PP19.7 – Grand Coulee Dam**) capture and temporarily hold floodwaters upstream of flood prone areas. After the flood threat has passed water is released at a rate that the river can accommodate.
  - b. As a stream impoundment with controllable outlets, they are most frequently used on small and moderate sized watercourses (U.S. Water Resources Council, 1981, p. 30).

2. Beneficial Attributes
  - a. Dams can reduce flood elevations for a given stretch of river and across a defined area downstream of the structure.
  - b. Reservoirs may be multipurpose, i.e., flood control, recreation, water supply, irrigation, and navigation.
  - c. Reservoirs may create desirable ecosystems, such as wetlands on former uplands.
  - d. Private property values along shorelines usually increase as a result of access to the reservoir.
  - e. Economic development may result from construction of a multipurpose reservoir.
  - f. Little or no disruption to land use activities as the protected properties are for the most part downstream from the project.
3. Detrimental Attributes
  - a. Reservoirs will change ecosystems, for example open water may replace wetlands as the pool level rises. This may be undesirable.
  - b. Dams and reservoirs require acquisition of project lands for buffers, the structure, and the pool. This acreage is removed from development or its historic value may be lost.
  - c. Dams are not cheap especially in an urban setting.
  - d. Reservoir can lose their flood storage capacity as a result of sedimentation and filling.
  - e. Dams like other structural projects instill a false sense of security. Development encroaches onto supposedly protected floodplains.
  - f. Dam failure will cause catastrophic loss of life and destruction of property. On June 5, 1976 the Teton Dam in southeast Idaho failed. When the earthen dam breached 250,000 acre-feet of water rushed down the valley and onto the flat farmlands. Rexburg, ID and other small farming communities were flooded, resulting in 11 deaths and over \$400 million damages.
  - g. A new and growing concern is that large structural projects are potential targets for terrorist attacks. This is particularly true of large dams and reservoirs, large levees, and floodwalls. This not only presents a safety hazard, but can add significantly to annual Operations and Maintenance costs.

B. Levees and walls (**PP19.8 – Levees and Walls**)

1. Functions

- a. Levees along the Mississippi River (**PP19.9**) and walls such as in the French Quarter of New Orleans (**PP19.9**) reduce the size of the floodplain or floodway by confining flow.
- b. Using sheet piles or concrete walls allows for a narrower rights-of-way. (Explanation note: Sheet pile is 3/8 in X 18 in X 40 +/- ft lengths of sculptured steel or plastic designed to interlock and prevent seepage.)

2. Beneficial Attributes

- a. In contrast to levees, a floodwall requires less right-of-way in developed areas and reduced seepage under or through the structure.
- b. Depending on the location levees may be less expensive to build than floodwalls. However, consideration must be given to the cost of rights-of-way.
- c. Levees and floodwalls can be located and built to protect specific areas and groups of structures.
- d. Levees can be designed as multipurpose facilities allowing construction of roads, trails, or bike or jogging paths on their crest or within their right-of-way. Such multiple uses are amenities for the community.

3. Detrimental Attributes

- a. Levees are mostly used along larger rivers where space is available for rights-of-way. Floodwalls in the same location would be more expensive.
- b. Earthen levees usually require wide rights-of-way because their base must be broad and in proportion to their height.
- c. Similar to dams and reservoirs, levees and walls encourage a false sense of security in those who live within the system. When failure such as overtopping occurs, the resultant damages can be catastrophic.

- d. Unless make part of a watershed or comprehensive community plan with mitigation flood frequency and depths and erosion are simply shifted to other areas of the floodplain or along the channel.
- e. Secondary consequences of these structures include:
  - loss of access to adjacent lands, essentially isolating the community from the watercourse;
  - modification of habitats due to fill, excavation, ponding, or drainage;
  - a need for pump systems to remove internal runoff;
  - an obstruction of views; and
  - limiting access to the natural functions of the river.

C. Channel alterations (**PP19.10**)

1. Function

- a. Channel alterations such as straightening, deepening, widening, removing debris (**PP19.11 - Picture of Bayou Fountain** ), paving, raising or enlarging the bridges and culverts, and removing dams can increase the carrying capacity of watercourse (U.S. Water Resources Council, 1981).
- b. Channel alterations by also lower flood elevations.

2. Beneficial Attributes

- a. Channel alterations reduce the extent, and duration of floods.
- b. Channel alterations can protect specific sites of localized flooding in developed areas.
- c. Channel alterations may be designed as part of a multipurpose project that not only serves for flood reduction but also navigation and recreation.
- d. Removing dams can restore natural ecosystems, including fish migration and canoeing.

3. Detrimental Attributes

- a. Changing the natural regime and storage capacity of the watercourse will accelerate runoff that may cause added flooding downstream.
- b. Channel deepening of larger streams must include a dredge maintenance component in order to maintain

- the capacity of the channel, an expensive action for the local sponsors.
- c. Modified channels will try to return to their original meandering configuration, requiring ongoing maintenance to keep the channel in the project location.
- d. Channel alteration results in habitat modification such as loss of wetlands, covering of shellfish beds, and removal of submerged aquatic vegetation, forced relocation of fish and shellfish, and changed migration routes.

#### D. Diversions (**PP19.12**)

##### 1. Functions

- a. Diversions sometimes called spillways (**PP19.13 - Bonnet Carre**) capture a predetermined flow from the watercourse such as 50% of the 100-year flood discharge and route the water through an artificial channel to receiving bodies (lakes, estuaries, larger rivers, adjoining watersheds). (U.S. Water Resources Council, 1981). In the example of the Bonnet Carre Spillway it can divert 250,000 cfs from the Mississippi River into Lake Pontchartrain, thereby reducing flood stage at New Orleans, LA.
- b. The placement of diversions is dependant on the landscape, the topography (the flatter the better), geology, and similar physical and biological factors and the ability of a receiving body to handle the additional flow.

##### 2. Beneficial Attributes

- a. Diversion can reduce flood levels affecting developed areas that are immediately downstream from the project.
- b. Diversion structures may use parcels of land that are less expensive than the highly urbanized area that might otherwise be protected with a levee.

##### 3. Detrimental Attributes

- a. Like dams, levees, and floodwalls, diversions give that false sense of security in the "protected area".
- b. Although the diversion structure may be small, the right-of-way for the channel (canal) may require significant land to allow for maintenance roads,

account for bank erosion and stabilization, and safety fencing.

- c. State laws may prohibit interbasin transfer of water.

E. Land treatment (**PP19.14**)

1. Functions

- a. Land treatments are improvement practices to reduce runoff from throughout a watershed (uplands as well as floodplains) (**PP19.15**). This requires modifying the landscape (physical, biological, and socioeconomic systems) to reduce flooding downstream.
- b. Land treatment practices include, but are not limited to: protecting forests and the under story, planting vegetative cover, terracing, slope stabilization, grass waterways, contour plowing, and strip farming (U.S. Water Resources Council, 1981).

2. Beneficial Attributes

- a. Land treatments are most commonly used on agricultural lands to slow runoff, improve infiltration of precipitation into the soil, and help maintain or recharge aquifers.
- b. Land treatment reduces erosion and subsequent sediment that fills streams and reservoirs.
- c. Selected land treatments (no till or minimum tillage) result in little or no additional costs to the agricultural community. In fact, technical and financial assistance are available through federal programs and the Cooperative Extension Service.

3. Detrimental Attributes

- a. Individual actions have limited impacts. On a watershed basis, a comprehensive program must be developed and implemented.
- b. Land treatment works best on smaller, upland watersheds rather than in larger river basins.

F. Onsite detention (**PP19.16**)

1. Functions

- a. Onsite detentions (**PP19.17 -Picture of onsite detention**) are typically small impoundments with

uncontrolled outlets that are created by building a dam/ embankment, by excavation, or by a combination of these.

- b. Onsite detention systems prevent or retard excessive runoff from lands stripped of vegetation or covered by impervious surfaces (buildings, parking lots, roads, sidewalks, etc.) from reaching a watercourse.
- c. In part, the runoff problem can be addressed by restricting land clearing and providing for temporary storage of runoff from a property (U.S. Water Resources Council, 1981).

## 2. Beneficial Attributes

- a. Onsite detention captures runoff to streams while at the same time trapping pollutants (i.e., improving water quality).
- b. When properly planned, onsite detention systems can be multipurpose, providing habitat for wildlife or serving as recreation fields during non-flood periods.
- c. Many communities can easily integrate onsite detention systems into existing and proposed development such as using rooftops, in low-lying areas, and as a part of a parking lot.
- d. When developers account for onsite detention early in the planning process, costs can be kept to a minimum.
- e. Communities can assess the developer for the needed additional services such as drainage systems or pumps.
- f. Onsite detention means the developer does not profit at the expense of others by passing excess runoff to flood downstream land uses and require public works projects to reduce this flooding.

## 3. Detrimental Attributes

- a. In some instances initial costs fall on the landowner who simply passes the costs on to the buyer or developer. On the other hand, the public pays for the detention system when it is part of a multipurpose project, such as using a recreation field to temporarily hold excessive runoff. Of course when integrated into a development or community program, land treatment costs are shared by the public and private sectors.

- b. Maintenance may be costly if not factored into the design and performed regularly. Consequently, without proper care a detention system loses its effectiveness.
- c. To maximize benefits and reduce additional flooding project design must be designed and coordinated with similar actions in the watershed. Improper design usually an undersized basin can actually increase runoff by combining peak flows with other runoff.
- d. Some communities require onsite detention systems be fenced or screened to reduce liability. However, some detention basins are either dry except during flood (recreation fields or water features) and are integrated into the land use plan. Communities may not require fencing for such features.

**Objective 19.2      Explain the beneficial and detrimental attributes of nonstructural mitigation practices**

**I.                    Nonstructural measures – general (PP19.18)**

- A.      Nonstructural measures are practices or approaches that
  - 1.      modify the susceptibility to flood damage and disruption
    - or
  - 2.      modify the flood impact
    - on the individual and the community.
- B.      Nonstructural measures keep people and development that may be damaged out of the flood hazard area or makes such activities more resistant to damage.
- C.      Along these same lines, nonstructural measures can reduce the financial and social impacts of flooding through programs that involve little or no construction and have a low capital cost (U.S. Water Resources Council, 1981).
- D.      Nonstructural measures are traditionally grouped into two categories. (U.S. Water Resources Council, 1981, p. 30) **(PP19.19 – Nonstructural Measures):**
  - 1.      Modify susceptibility to flooding
    - a.      Floodplain regulations
    - b.      Development and redevelopment

- c. Warning and preparedness
  - d. Flood proofing
- 2. Modify impact of flooding
  - a. Flood insurance
  - b. Relief and recovery

### **Interactive Class Activity:**

Ask students to name specific examples in their area that are instances of nonstructural mitigation.

## **II. Nonstructural mitigation practices - specific categories**

- A. Floodplain regulations (**PP19.20**)
  - 1. Functions
    - a. Floodplain regulations usually designate mapped flood prone areas and limit their uses to those activities that are compatible with the degree of flood risk, such as restricting parking along floodprone streets (**PP19.21 - Picture of No Parking sign**).
    - b. In other words, development of flood prone lands is made more compatible with natural processes and systems. (U.S. Water Resources Council, 1981)
  - 2. For local governments to implement floodplain regulations, they must:
    - a. Build on existing enabling statutes or home rule powers similar to what is used for zoning regulations or building codes;
    - b. Implement practical and reasonable regulations for attaining their goals;
    - c. Maps and regulations must be based on technical data that will satisfy a court;
    - d. Not discriminate between similarly situated landowners; and
    - e. Not "take" private property without payment of just compensation. (U.S. Water Resources Council, 1981)
  - 3. Beneficial Attributes
    - a. Floodplain regulations are flexible and allow for integrating economic, environmental, and social values.

- b. Floodplain regulations can become effective quickly, thereby reducing the potential for loss of life and property damage almost immediately.
  - c. Federal, state, and local agencies can usually provide technical information needed for floodplain regulations.
  - d. Floodplain regulations can prevent unwise development and stop or slow actions as the community plans for other activities. At the same time they protect buyers when they purchase property and structures in floodplains.
  - e. The community's cost of floodplain regulations to is minimal when compared to the impacts of a flood.
  - f. Floodplain regulations protect the ability of floodplains to carry floodwaters, prevent increases in flood heights, or not otherwise contribute to flooding problems.
  - g. Flood regulations help contain the costs of emergency operations, relief, evacuation, and restoration.
  - h. Government action reduces the need for future expenditures for construction, operation, and maintenance of reservoirs, levees, and other flood control measures.
  - i. When structures are damaged by a flood or other disaster or have been remodeled (including expansion), the structure must be brought into compliance with the most recent statutes or codes.
  - j. Finally, natural floodplain values and functions are preserved.
4. Detrimental Attributes
- a. This is not the best method for correcting existing problems because regulations usually exempt existing development from immediate compliance.
  - b. Unfortunately, local floodplain regulations may be easily changed. Modifying federal programs such as the National Flood Insurance Act will not be as readily modified.
  - c. Landowners may experience monetary losses if the regulations prevent the land from being used for development. Research indicates that the loss in value, however, is the greatest from actual flooding.
  - d. Floodplain regulations have little impact in areas of slow or no growth.

- e. Communities adopt the minimal required by the NFIP and assume they have a good program. They should design a flood damage reduction program that fits their location and is in compliance with the NFIP.

B. Development and Redevelopment Policies. **(PP19.22)**

1. Functions

- a. Local governments can encourage and direct development and redevelopment away from floodways and floodplains (U.S. Water Resources Council, 1981).
- b. For example, placing schools, government buildings, and critical facilities outside of floodprone areas draws associated, dependant businesses away from floodplains.
- c. Development policies can tie future development to comprehensive community plans and require that adverse impacts be mitigated before the development can proceed.
- d. To addressing flooding, local governments may:
  - 1'. Place signs identifying floodplains and giving depths of previous floods.
  - 2'. Require deeds give the floodplain designation of the property, such as an A zone or a V zone;
  - 3'. Tax floodplains in a way that encourages their use as open space or for low-density development.
  - 4'. Offer tax credits for mitigation activities, such as flood proofing, elevating, or relocating.
  - 5'. Buy properties as either a part of their mitigation plan, when a community locates a flood servitude, or as part of another project such as upgrading a thoroughfare **(PP 19.23 – Picture of development and redevelopment examples)**.

## 2. Beneficial Attributes

- a. Local governments can control the construction of utilities, sewer service, and highways onto floodplains and establish lines that restrict encroaching into channels and floodways, thereby reducing the need for repair and replacement after a flood.
- b. When comprehensive community plans are developed, acquired land can be used as open space for parks and storm water detention ponds.
- c. Acquisition and relocation removes the structures from the floodplain. It no longer is subject to damage.
- d. Comprehensive planning should prevent adverse impacts and losses resulting from future development and reduce the community's liability for actions that might allow development that results in adverse impacts on other properties.

## 3. Detrimental Attributes

- a. Cultural enclaves may lose their identity if individuals are dispersed to sites outside the floodplain. Once they leave, they may no longer associate with traditional symbols of the community, such as churches, fraternal/social halls, cemeteries, etc.
- b. People may leave the community even if the cultural enclave maintains its identity.
- c. This option can be expensive if the property is simply cleared for open space. Costs can be reduced by coordinating with other community programs and goals.

## C. Warning and preparedness (**PP19.24**)

### 1. Functions

- a. Forecast and warning models help the National Weather Service, River Forecast Centers, local governments, and private companies estimate the projected severity and schedule of a flood. Much of

the basic data need for these models are from USGS river stage gauging stations (**PP19.25 – Picture of River Stage Recorder**) located throughout a watershed.

- b. Flood warnings and preparedness (planning for floods (**PP19.25**)) give communities and individuals time to take action in anticipation of rising waters. For example, when exceptional precipitation is anticipated or in regions characterized by flash floods, people may evacuate from the most dangerous locations by climbing up the valley walls to escape high velocity flows which have a history of loss of life.
- c. Flood warnings give potential victims a chance to reduce or prevent flood damages to their property by:
  - 1'. removing or elevating a home's contents (furniture, appliances, personal possessions) or commercial inventories, or
  - 2'. protecting valuables by sand bagging, installing temporary walls, closing openings, or patrolling levees.
- d. Warning systems for entire watersheds are getting more common and now give real-time information from gauging stations over the internet (**PP19.25**).
- e. Information gets to the general public from local sources, such as TV weather segments during the regularly scheduled news time, interrupted broadcasts, and newspapers.

## 2. Beneficial Attributes

- a. By giving communities and individuals time to prepare warnings help save lives and reduce property damage.
- b. Early information guides decision makers when distributing sand, sandbags, and other emergency protection materials.
- c. Dam and levee boards use this information for the safe operation and protection of their structure.

- d. However, collecting needed information on precipitation, river stage readings, and duration, can be expensive unless an agency organizes volunteers to record and transmit information. Although new automatic recording instruments are in place at some locations, the volunteer may never be replaced.

### 3. Detrimental Attributes

- a. Vandalism of real- time gauges is a problem. Stealing or using them as targets can eliminate an important source of data when they are most needed. Consequently the stations may be inoperable during a critical period as they are expensive to install, update, operate, and replace.
- b. Because the initial costs for a system (setup, gauge acquisition and installation, monitoring networks) are expensive, federal budgets are restricted, and local matches are almost impossible to obtain only a limited number of watersheds have sufficient stations to provide needed data for models. Budget woes are resulting in a decrease in gauges.
- c. Storms may interrupt the power and telephone networks. As a result even though volunteers have collected much needed data they cannot transmit it during or immediately after a storm.
- d. Operating and testing a warning system and forecast model can be expensive and time consuming.

## D. Flood proofing (**PP19.26**) (U.S. Water Resources Council, 1981)

### 1. Functions

- a. Flood proofing may be viewed in two ways:
  - 1'. as a group of techniques used to keep water out of buildings or to reduce damages caused by water, and
  - 2'. as techniques that require human intervention, i.e., permanent measures, contingent or standby measures, or emergency measures.

- b. Existing buildings and facilities can be retrofitted with watertight doors and water-resistant materials **(PP19.27 – Elevated house and elevated Burger King )**. However, it is usually more cost effective to flood proof during initial construction.
- c. Dry flood proofing (watertight closures, sealant on walls, plastic sheeting) keeps the water away from people or out of a building
- d. On the other hand, wet flood proofing allows the water to enter a building. Water-resistant materials and practices, removal of contents, raising appliances (furnace, water heater, washer/dryer) above the flood level, or limiting the use of space reduce flood damages.
- e. Permanent flood proofing measures can be integrated into a structure in ways that obscure their visual impact **(PP19.28 – Picture of floodwalls and flood resistance floor tiles)**.
  - 1'. Examples include sealing openings with bricks or other flood resistant materials, elevation, relocation, or acquisition.
  - 2'. These usually do not require any human intervention for them to be effective.
- f. Flood proofing is more appropriate for structures on floodplains where inundation is shallow, infrequent, and has low velocity.
- g. Contingent or standby measures are installed before an expected event and are ready for use during a flood.
  - 1'. Examples: panels across doors or openings, window coverings, walls and pumps. However, to make these effective someone must operate them.
- h. Emergency measures are implemented during a flood and are most effective when operated according to a plan.
  - 1'. Examples: sandbags, temporary walls and pumps, removal of contents, raising contents. Major efforts by individuals or

communities are necessary for these to be effective.

2. Beneficial Attributes

- a. Flood proofing is more applicable to commercial structures. Businesses can afford engineers or architects to design a project that is professionally installed.
- b. Generally, commercial structures are better able to withstand floodwaters. In addition, the potential benefits are high relative to the costs of flood proofing.
- c. Damages can be prevented to a prescribed level and on a selective basis, such as a specific structure or activity (relocating or elevating a hot water heater or A/C unit).
- d. In some instance such as raising a washer and dryer on cement blocks flood proofing is easy, inexpensive, and quick.
- e. Flood proofing also reduces the disruption of activities, helps maintain essential services during and after a flood, and contributes to faster post-flood recovery.
- f. Flood proofing is applicable to individual units, one building or a small cluster of structures, unlike projects such as dams and levees that protect large areas.

3. Detrimental Attributes

- a. Similar to dams and levees flood proofing can instill a false sense of security, thereby encouraging inappropriate or unwise uses of buildings or floodplains.
- b. When floodwaters exceed the level of protection (dry flood proofed to two feet, but the flood is 2.5 feet), costs can be significant. In fact, dry flood proofing of residential structures is only recommended to two feet of flooding.
- c. If flood proofing techniques are improperly applied, water pressure against the structure may cause its collapse.

- d. Even though flood proofing can protect critical facilities (hospital, fire station, police station), these facilities may not be operable if they cannot be reached because the roads are impassable - and during an emergency when they are most critical.
- e. Finally, flood proofing can be costly. For example it may be better to demolish and rebuild a structure rather than elevate a slab-on-grade foundation.
- f. Only the structure is protected. As people move to or from the structure they must cross flooded lands.

E. Flood insurance (**PP19.29**) Flood insurance was discussed in detail in Session 18.

1. Functions

- a. The Federal government provides property owners anywhere within the limits of a participating community the opportunity to purchase flood insurance for structures and contents (Catalog of Federal Domestic Assistance, 97.022).
- b. Flood insurance is available through the National Flood Insurance Program at FEMA, now a division within the Department of Homeland Security.
- c. To participate, the community must adopt and enforce floodplain management measures applicable to the Special Flood Hazard Area (**PP 19.30 – Lake Charles FIRM**). An approved regulatory program is designed to reduce future flood damages. Flood insurance is obtained through private property insurance agents.

2. Beneficial Attributes

- a. Nationally, by 2003 over 19,500 of 22,000 communities with identified floodplains participate in the National Flood Insurance Program.
- b. Congress has established the NFIP as a self-supporting program. Consequently, administrative costs, mapping, and other NFIP expenses are paid through insurance premiums and fees from map

revision requests. This reduces the costs to the taxpayer for disaster assistance.

- c. Insurance claims, unlike loans (principle plus interest), do not have to be repaid.
- d. As of 2004 total building coverage available on a single-family dwelling is \$250,000 plus contents (insurance coverage limits of \$100,000) while grants are very small (sometimes only \$10,000).
- e. Similar to all insurance programs the NFIP spreads the cost of insurance through time and over and across a large number of properties that are at risk.

### 3. Detrimental Attributes

- a. To be eligible for flood insurance a property owner must maintain their flood insurance policy and pay the premiums.
- b. Communities must enforce floodplain regulations on how properties within the Standard Flood Hazard Area may be used or constructed or reconstructed.
- c. Does not reduce damages. To gain lower premiums owners are encouraged to reduce their exposure. The Community Rating System does the same thing for communities.

## F. Relief and recovery (**PP19.31**)

### 1. Functions

- a. Relief and recovery efforts from the public and private sectors help the individual, business owner, and community after a flood (**PP19.32 – Red Cross Truck**).
- b. Relief and recovery measures include cleanup, resumption of services, application of federal and state disaster aid.
- c. In addition, tax adjustment may allow credits or deductions for the costs of repairs and rehabilitation. Creative governments can use tax

adjustments to influence how one rebuilds or uses flood prone areas.

- d. The Federal government provides loans and grants through several programs. These will be discussed in more detail in Session 20 next week.
- e. Communities with a recovery and mitigation plan are more effective in implementing post flood recovery in the shortest possible time. Important elements in this plan are provisions to mitigate structures at risk and eliminate unwise redevelopment on floodprone lands, thereby minimizing future flood losses.

## 2. Beneficial Attributes

- a. Organized response and recovery initiatives minimize interruption of businesses and disruption of utilities and transportation networks.
- b. During and after a flood, many federal and state programs and nonprofit organizations, e.g. Red Cross, can assist with debris removal, shelter and feeding victims, and rehabilitation of public services.
- c. During recovery, the local government may be presented an opportunity to eliminate flood damaged development by elevating, floodproofing them or buying them and relocating the victims. Finally, structures can be rebuilt in ways that minimizes future flood losses.

## 3. Detrimental Attributes

- a. Unless government takes the time to use tax credits and deductions to guide redevelopment of floodplains these potential incentives will not provide protection against future flood damages. Redevelopment property without proper mitigation simply allows for the continuation of the damage-rebuild-damage cycle of the past.
- b. In fact, poorly structured tax adjustments may encourage continued unwise use of floodplains or even more development.

- c. Effective recovery requires forethought as expressed in a plan. Unless the community has a strategy for debris clearance, restoration of utilities, infrastructure, and public services victims face a protracted period of recovery.
- G. General concerns about nonstructural measures (ASFP, 2001, p. 50) **PP19.33**
  - 1. Acquisition and relocation are often done piecemeal, leaving what is called a checkerboard pattern of vacant lots and buildings that either didn't qualify for the program or whose owners did not want to move.
  - 2. Elevation and flood proofing projects still leave buildings surrounded by floodwaters during a flood.
    - a. Occupants often try to ride out the flood or get to or from their properties during high water, requiring significant police and fire protection costs.
    - b. The building may be isolated and without utilities; therefore temporarily unusable.
  - 3. Owner-designed measures (if allowed), especially dry flood proofing, may not adequately account for all forces that floodwaters place on a building.
    - a. This can result in severe structural damage to the building.
  - 4. The streets, utilities, and other infrastructure that serve an elevated or flood proofed building are still exposed to flood damage and public costs for those damages.

### **19.3 Apply mitigation practices to a flood problem**

#### **Homework Exercise**

Students will be divided into teams and assigned the task of developing one of the flood mitigation measures as it applies to the watershed within their community and the problems they identified in their risk assessment. Each team reports on its recommended mitigation measures. The class as a whole will develop a complete mitigation program for the watershed. Students may get some ideas on the success of mitigation measures by reviewing the Association of State Floodplain Managers series on "Mitigation Success Stories" available on the ASFP website: [www.floods.org](http://www.floods.org).

Alternative exercise: Each student selects an example of one existing mitigation measure in their local area and writes a short (one to two page) analysis of the beneficial and detrimental attributes and any history of the decision to take this mitigation approach. They can use some of the examples that students brainstormed earlier in the session.

## **Handouts**

### **Handout 19H1**

**NO ADVERSE IMPACT (NAI)** floodplain management is an approach that insures the action of any community or property owner, public or private, does not adversely impact the property and rights of others (ASFPM, 2003, p. 3).

**NONSTRUCTURAL APPROACHES** - includes all other adjustments (e.g., regulations, insurance, etc.) in the way society acts when occupying or modifying a floodplain (FEMA, 1986, p. IV-1). Nonstructural approaches generally are applied to individual structures, as opposed to structural measures that are generally adjust the waterway or floodplain to fit human needs.

**NONSTRUCTURAL MEASURES** - A term originally devised to distinguish techniques that modify susceptibility to flooding (such as regulation, floodplain acquisition and flood proofing techniques) from the more traditional structural methods (such as dams, levees, and channels) use to control flooding (L.R. Johnston, 1992, p. C-7).

**NONSTRUCTURAL MEASURES** - All floodplain management measures excepting structural flood control works. Examples of nonstructural measures are flood warning/preparedness systems, relocation, flood proofing, regulation, land acquisition, and public investment policy (United States Water Resources Council, 1981, p. A - 4).

**NONSTRUCTURAL MEASURES** - fall into two broad categories, those that modify the susceptibility to flood damage and disruption, and those that modifies the impact of flooding on individuals and on the community (U.S. Army Corps of Engineers, 1983, p. 13).

**STRUCTURAL APPROACHES** - adjustments that modify the behavior of floodwaters through the use of measures such as public works, dams, levees and channel work (FEMA, 1986, p. IV-1).

**STRUCTURAL MEASURES** - Measures such as dams, reservoirs, dikes, levees, floodwalls, channel alterations, high flow diversions and spillways, and land treatment measures designed to modify floods (L.R. Johnston Associates, 1992, p. c-9).

**STRUCTURAL MEASURES** - Flood control works such as dams and reservoirs, levees and floodwalls, channel alterations, seawalls, and diversion channels which are designed to keep water away from specific developments and/or populated areas or to reduce flooding in such areas (United States Water Resources Council, 1981, p. A-5).

**STRUCTURAL MEASURES** - direct flood waters into desired paths (U.S. Army Corps of Engineers, 1983, p. 13).

## **List of PowerPoint**

- 19.1. FLOODPLAIN MANAGEMENT. Mitigating Flood Losses
- 19.2. FLOODPLAIN MANAGEMENT. Mitigation Measures
- 19.3. FLOODPLAIN MANAGEMENT. No Adverse Impact
- 19.4. FLOODPLAIN MANAGEMENT. Structural Mitigation Practices
- 19.5. FLOODPLAIN MANAGEMENT. Disadvantages w/ Structural Measures
- 19.6. FLOODPLAIN MANAGEMENT. Dams and Reservoirs
- 19.7. FLOODPLAIN MANAGEMENT. Dams and Reservoirs
- 19.8. FLOODPLAIN MANAGEMENT. Levees and walls
- 19.9. FLOODPLAIN MANAGEMENT. Levees and walls
- 19.10. FLOODPLAIN MANAGEMENT. Channel alterations
- 19.11. FLOODPLAIN MANAGEMENT. Channel alterations
- 19.12. FLOODPLAIN MANAGEMENT. Diversions
- 19.13. FLOODPLAIN MANAGEMENT. Diversions
- 19.14. FLOODPLAIN MANAGEMENT. Land Treatment
- 19.15. FLOODPLAIN MANAGEMENT. Land Treatment
- 19.16. FLOODPLAIN MANAGEMENT. Onsite detention
- 19.17. FLOODPLAIN MANAGEMENT. Onsite detention
- 19.18. FLOODPLAIN MANAGEMENT. Nonstructural measures
- 19.19. FLOODPLAIN MANAGEMENT. Nonstructural measures
- 19.20. NONSTRUCTURAL MEASURES. Floodplain regulations
- 19.21. NONSTRUCTURAL MEASURES. Floodplain regulations
- 19.22. NONSTRUCTURAL MEASURES. Development and Redevelopment Policies
- 19.23. NONSTRUCTURAL MEASURES. Development and Redevelopment
- 19.24. NONSTRUCTURAL MEASURES. Warning and preparedness
- 19.25. NONSTRUCTURAL MEASURES. Warning and preparedness
- 19.26. NONSTRUCTURAL MEASURES. Floodproofing
- 19.27. NONSTRUCTURAL MEASURES. Floodproofing I
- 19.28. NONSTRUCTURAL MEASURES. Floodproofing II

19.29. FLOODPLAIN MANAGEMENT. Flood Insurance

19.30. FLOODPLAIN MANAGEMENT. Flood Insurance

19.31. FLOODPLAIN MANAGEMENT. Relief and recovery

19.32. FLOODPLAIN MANAGEMENT. Relief and recovery

19.33. NONSTRUCTURAL MEASURES. General Concerns